

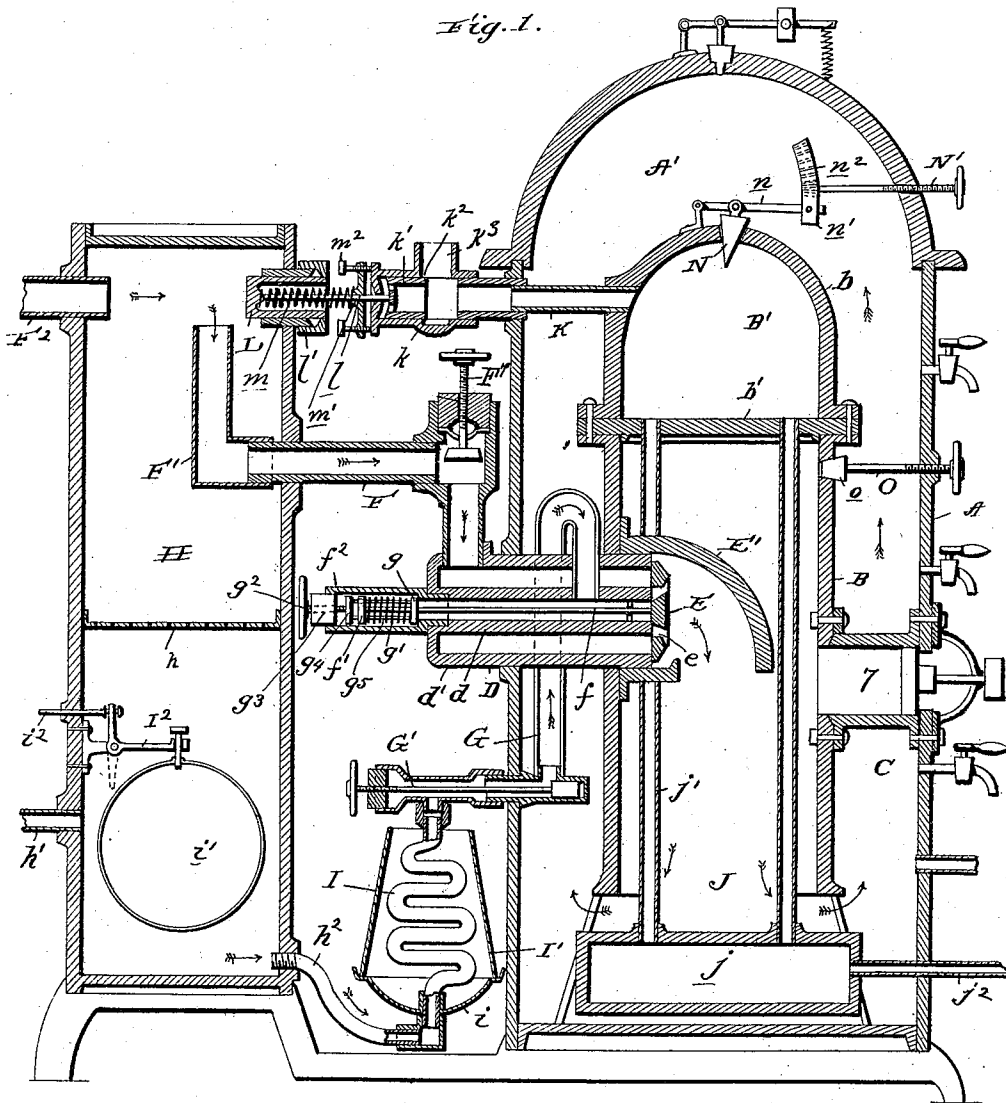
(No Model.)

4 Sheets—Sheet 1.

T. A. MARRIOTT.
STEAM BOILER.

No. 519,386.

Patented May 8, 1894.



Witnesses:

C. H. Raeder
J. M. Copenhaver.

Inventor

Thomas A. Marriott

By James Sheehy
Attorney

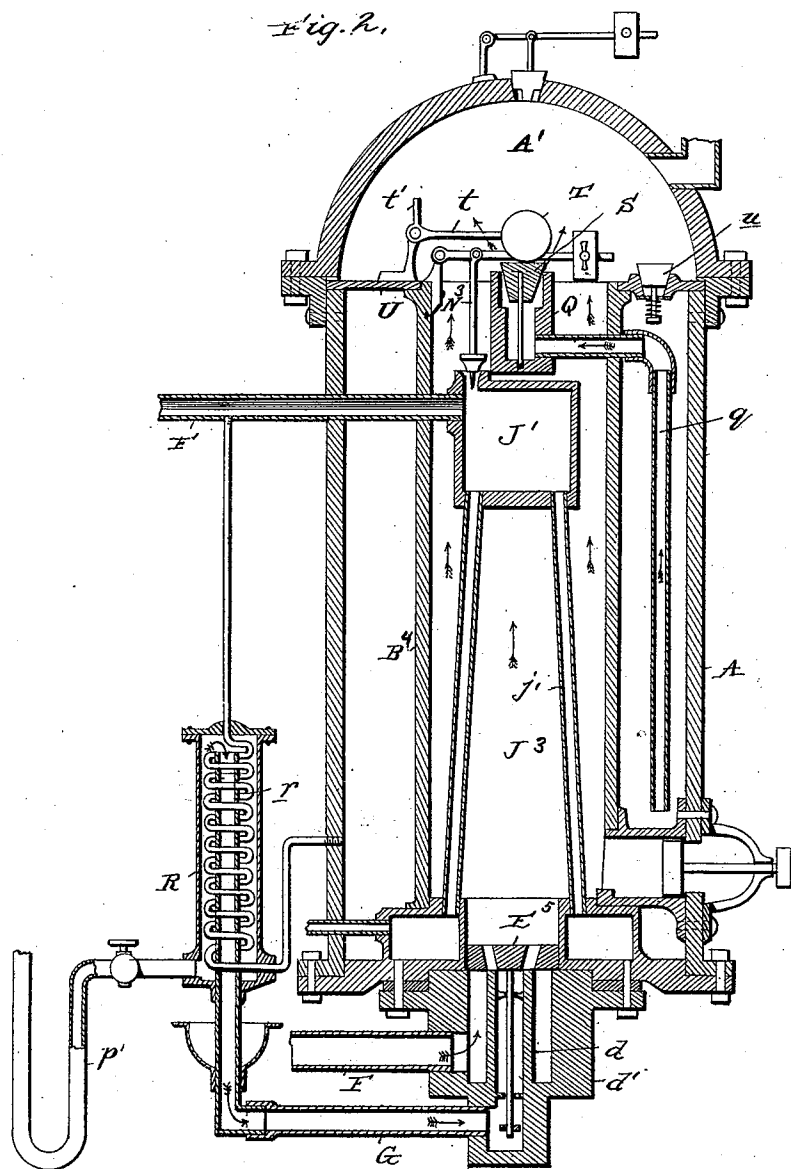
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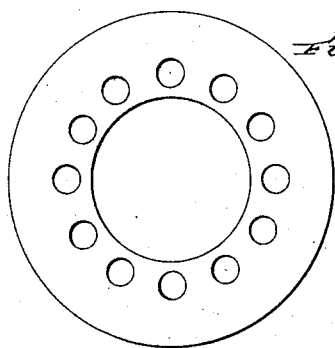
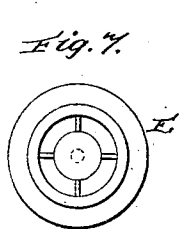
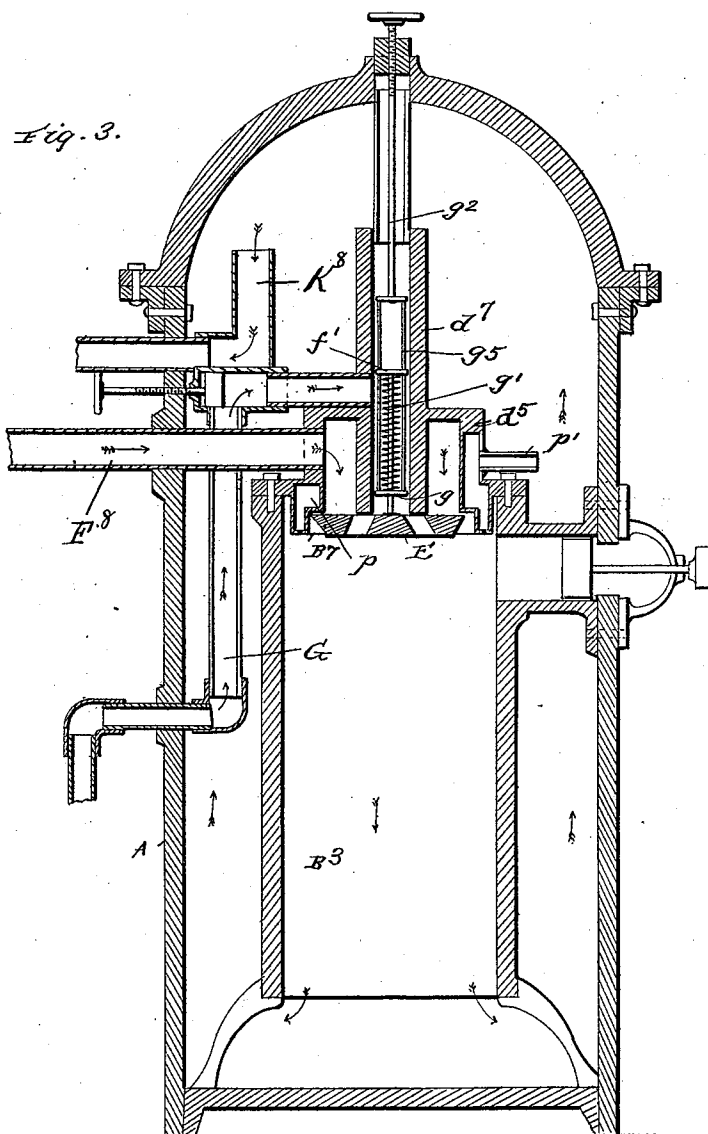
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4 Sheets—Sheet 3.

T. A. MARRIOTT.
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No. 519,386.

Patented May 8, 1894.



Witnesses!

C. A. Raeder

J. M. Copenhaver.

Inventor

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Attorney

(No Model.)

4 Sheets—Sheet 4.

T. A. MARRIOTT.
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No. 519,386.

Patented May 8, 1894.

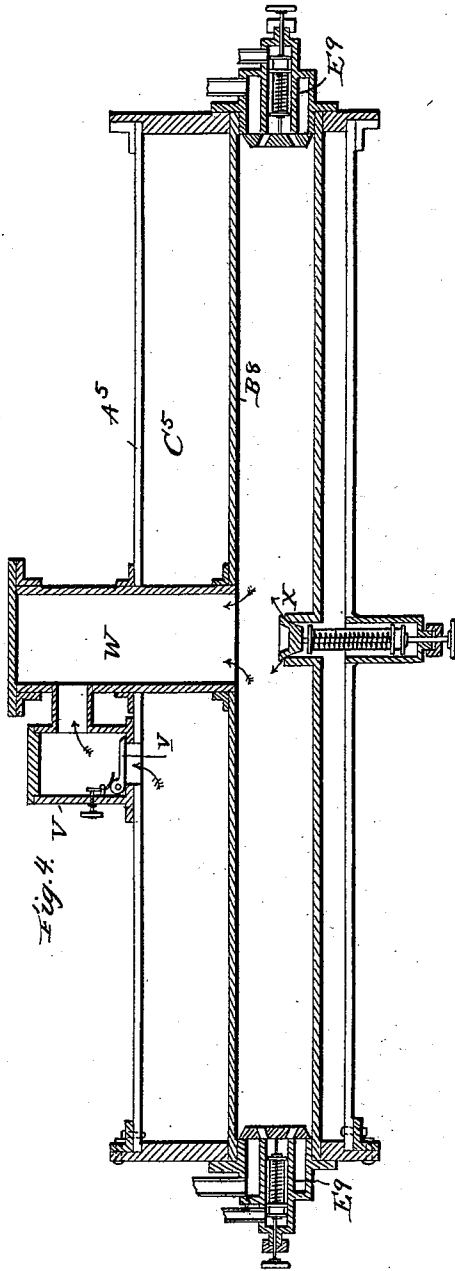


Fig. 4.

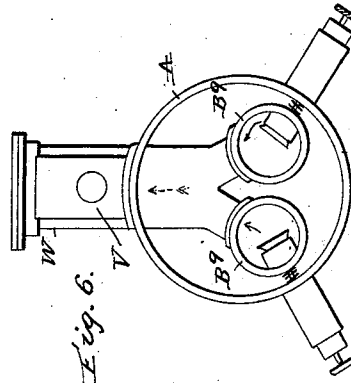


Fig. 6.

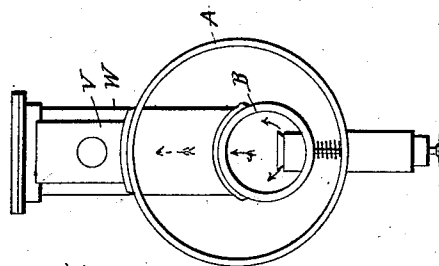


Fig. 5.

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UNITED STATES PATENT OFFICE.

THOMAS A. MARRIOTT, OF NEWBERRY, MICHIGAN.

STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 519,386, dated May 8, 1894.

Application filed March 24, 1892. Serial No. 426,267. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. MARRIOTT, a citizen of the United States, residing at Newberry, in the county of Luce and State of Michigan, have invented certain new and useful Improvements in Steam-Boilers; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to a method of and apparatus for generating steam, which will be hereinafter fully described and claimed.

The primary object of this invention is to utilize the entire volume of heat generated by the combustion of fuel, and augmented by the plentiful supply of atmospheric air, in the conversion of water into steam for power or other purposes.

A further object of the invention is to produce an improved generator or boiler, which, in comparison with the common form of flue or tubular boiler, is very materially reduced in size, is simpler and cheaper in construction, and is capable of more rapid generation of steam, thereby effecting economy in the consumption of fuel and producing a greater volume of steam, in proportion to the fuel consumed.

The improved generator is provided with appliances which automatically govern and control the feeding of fuel and air to the combustion chamber, and the discharge of steam to the motor or engine for feeding the fuel and air required for the automatic running of the boiler or generator, thus dispensing with manual labor in stopping the furnace and removing ashes therefrom.

The first part of my invention therefore, consists in a method of generating steam which consists, first, in commingling gaseous fuel under pressure with compressed air, and then discharging a highly heated current of commingled air and gas directly into and through a body of hot water, effecting the immediate conversion of water and the hot aeriform current into a large volume of steam, which as will be seen, is augmented by the highly heated current of hot air and gas, whereby the water is vaporized by the direct action thereon of the current of heat instead

of by the radiation of the heat from the boiler, shell or a multiplicity of tubes or flues.

The second part of my invention relates to a generator or boiler, embodying an exterior shell, an inner shell forming a water space between itself and the outside shell, a burner which commingles two independent currents, one of compressed air and the other of gaseous fuel, and effects the combustion of the fuel which is discharged under pressure directly into a combustion chamber within the inside shell from whence the heated current is discharged directly into the body of hot water within the generator.

The boiler or apparatus further embodies an auxiliary high-pressure boiler within the inner shell, comprising a water tank in the lower part of the generator, a steam dome within the upper part of the internal shell, and connections or flues between the water chest and steam dome of said auxiliary high-pressure boiler, the dome of the latter having a valve-mechanism which operates automatically when there is excessive pressure in the steam dome of the high-pressure boiler, so that the steam in the latter is discharged into the main steam dome until the pressure in the auxiliary boiler is reduced to the normal pressure.

The invention further embodies a combined air and liquid fuel tank adapted to supply the air and gas combiner and burner, and a valve mechanism connected to said tank and to the steam supply pipe between the high-pressure boiler and the engine, said valve mechanism being automatically operated by excessive pressure of the air in the tank so partly or wholly cut off the steam supply to the engine, whereby the latter is slowed down or stopped to reduce the volume and pressure of air in the tank so that the air pressure is gradually reduced until it comes to the desired condition.

The invention further consists in the novel combination of devices and construction and arrangement of parts which will be fully described and particularly pointed out in the claims.

In the accompanying drawings I have shown several forms of boilers by which my invention embracing both the process of and

apparatus for generating steam can be carried into practice.

Referring to said drawings: Figure 1, is a sectional elevation showing one form of the generator in which the burner and mixer are supplied with compressed air and vaporized fuel gas obtained from the conversion of a suitable hydro-carbon oil. Fig. 2, is a sectional elevation of a vertical boiler in which the heat and gases are projected into and through a water spray. Fig. 3, is a similar sectional view of a simpler form of the vertical boiler of the type shown in Fig. 2. Fig. 4, is a sectional view through a horizontal boiler in which the heat and gases are combined and injected into a finely divided stream or spray of water to convert the same into steam. Figs. 5, and 6, are end elevations of the apparatus shown in Fig. 4, and a modified construction of said apparatus. Figs. 7, and 8, are detail views.

Like reference letters indicate corresponding parts in the several figures of the drawings.

Referring more particularly to the apparatus shown in Fig. 1, of the drawings: A, indicates the outer shell of the main boiler and B, is the inner shell, which shells are preferably annular in form and arranged concentric with each other to form a water chamber or space C, between the same. The shell A, is closed by a segmental head forming a steam dome A', therein, and the inner shell B, is likewise provided with a segmental closed head b, which receives a transverse diaphragm or partition b', forming a steam dome B', in the upper part of the internal shell which will be more fully referred to hereinafter, but the lower end of the internal vertical shell B, is left open and said shell B, is supported on suitable legs or brackets so that the lower open end of the internal shell is held above the closed bottom of the external shell A, thereby providing a continuous passage beneath the bottom of the internal shell to permit the highly heated current of hot air, heat and gases supplied by the combined mixer and burner to the internal shell into direct contact with the body of hot water contained between the two shells A, B.

D, is the combined mixer and burner which consists essentially of an inner annular member d, and an external annular member d', which is arranged around the inner member, concentric with the same, thereby forming the inner chamber surrounded by an outer chamber. The inner ends of the concentric annular members of the burner, are open to permit the currents of air and gaseous fuel to be commingled and combined at the point where said currents are discharged into the combustion chamber formed by and within the internal shell B, below the steam dome B', therein. The gaseous fuel is ignited practically at the point where the air combines therewith, converting the currents of air and fuel into a single current of heat of a very high temperature. The outer ends of the sec-

tions of the burner are closed as shown, the outer section by means of a solid head and the inner section by a stuffing box through which operates the means for regulating and adjusting the valve E, which controls the supply of fuel and air to the combustion chamber. This valve E, is of annular form, arranged to close the outlet openings from the members of the mixer and burner through which the air and gas pass to the combustion chamber, and in order to insure at all times a small flame at the burner, this valve is provided with transverse passages e, through which limited volumes of gas and air can pass even when the valve E, is closed against the open ends, of the section of the mixer and burner. Within the combustion chamber formed in the internal shell, I arrange a deflecting hood E', which curves downward and rearward over the valved open ends of the burner, and this hood operates to turn or deflect the highly heated current of air and gas from the burner in a downward direction so that the current will be properly deflected to pass into and through the body of hot water.

The valve E, of the mixer and burner is regulated and adjusted according to the tension at which it is desired to maintain the pressure in the internal shell and the air pressure. To the valve is connected a stem or rod f, which passes through the chamber in the internal member d, of the mixer and burner, and the outer end of this rod is fastened to a cross head f', operating in a cylinder or shell f'', on the rear end of the burner and mixer. Fitted loosely in the valve stem, at a point in advance of the cross head, is a collar g, and between the collar and the cross head is interposed a coiled tension spring g', which operates normally to hold the valve E, against the open discharge end of the burner and mixer. The tension of this spring can be varied by means of an adjusting screw g'', which works in a stuffing box g'', in the outer end of the cylinder or shell, said screw having a hand wheel for its convenient manipulation and swiveled at its inner end to an adjustable plate g'', which is connected by the tension rods g'', with the sliding collar g, on the valve stem. It is evident that the screw can be easily manipulated to vary the tension of the spring, either to increase or decrease the tension, without disturbing the position of the valve.

In Fig. 1, the mixer and burner enters the side of the two shells A, B, and is surrounded by the hot water or steam in the space C, between the shells; and the current of compressed air is supplied by a pipe F, to the chamber of the outer section d', of the mixer and burner, while gaseous fuel is supplied by a pipe G, to the inner section d, of said mixer and burner. The air pipe F, is provided with a normally operated valve F', adapted to be suitably seated in the elbow or other suitable seat in the pipe to cut off the supply of compressed air; and the gaseous fuel pipe G, is also

provided with a normally operated valve G' , of the slide pattern. The apparatus shown in Fig. 1, of the drawings is especially adapted for the use of heavy hydro-carbon oil as a fuel, which is vaporized on its passage from the tank and before its admittance to the inner section d , of the burner. The air and fuel to be supplied to the mixer and burner are adapted to be stored or contained in a single vertical tank H , which is divided into an upper and lower compartment by means of a horizontal partition h , which has one or a series of perforations so that the pressure of the atmospheric air in the upper part of the tank is utilized to force the liquid fuel under pressure into the atomizing contrivance from whence it passes into the supply pipe G , and thence to the inner section d , of the mixer and burner. The liquid fuel is admitted to the lower part of the tank H , through a supply pipe h' , and from the lower part of the tank leads a pipe h^2 , which conducts the liquid fuel to a vaporizing worm I , which is arranged in a vertical position and has its upper end connected to the valved gas pipe G . Around this coiled pipe I , is arranged a tapered hood I' , which serves to confine the heat within the inclosure formed by said hood around the coil I , and at the lower part of the hood is arranged a cap i , into which oil can be poured preparatory to starting the apparatus, whereby the oil can be ignited to heat the coil I , which will remain heated and serve to convert the liquid fuel as it is fed, into an inflammable vapor or gas which passes through the pipe G , into the mixer where it is commingled with air from the pie F , and burned as fuel. The air pipe F , extends from the mixer and burner to the upper part or air chamber of the compressing and distributing tank H , and said end of the air pipe terminates in an elbow F' , which extends vertically into the air chamber. The air from the pump or compressor is supplied to the distributing tank through a pipe F^2 , as shown.

The supply of liquid fuel to the lower part of the distributing tank is effected by means of the pipe h' , and this fuel supply is regulated by means of a float i' , arranged in the lower part of the tank H , and connected to the longer arm of a power lever I^2 , which is suitably fulcrumed on a fixed bracket within the tank, and the other short arm of this power lever has an endwise movable rod i^2 , connected thereto which extends to and controls the valve of the pump employed to force the liquid fuel through the pipe h^2 . If desired however, the fuel may be taken directly from an elevated barrel or tank, and a valve may be arranged in the pipe h^2 , to be closed by the upward movement of the float to shut off the supply of fuel and to be opened by the dropping of the float when the liquid descends and thus renew the supply of liquid fuel in the tank, which supply is thus automatically regulated and controlled. The position of the power lever I^2 , is not material as its

short arm may be above the fulcrum bracket or below the same as indicated in dotted lines.

Within the main boiler is arranged an auxiliary high pressure boiler J , consisting essentially of a water tank or reservoir j , the steam dome B' , and the flues or tubes j' , which connect the water tank and the steam dome. The water tank j , is annular in form, with a solid casting forming the shell thereof, and it is located in the bottom of the external shell A , below the open lower end of the internal shell B , a sufficient distance to provide for the free passage or escape of the heat and products of combustion from the internal shell, into the water space or chamber C ; and the tubes j' , extend through the internal shell B , to convey the steam generated in the water tank j , to the steam dome, and the water from the outside shell A , can be pumped or forced into said tank j , through a pipe j^2 .

The steam for running the engine or motor for operating the pumps, is taken from the steam dome of the auxiliary high pressure boiler, and to said steam dome B' , is connected a steam supply pipe K , which leads from the dome B' , through the steam dome A' , and enters a valve shell k , in which operates a piston valve k' , that is adapted to move across the outlet k^2 , of a pipe k^3 , that leads to the engine or motor. From this piston valve k' , leads a valve stem l , which is connected to a regulating valve L , in the form of a piston which reciprocates in cylinder l' , fixed to and communicating with the air chamber in the upper part of the tank H . Around this connecting stem between the two valves is fitted a coiled spring m , which bears at one end against the regulating valve L , and at its other end against an abutment m' , which is fitted loosely on the valve stem and is adjustable by means of the set screws m^2 , which work in the abutment and bear against the closed end of the valve shell k , so that the tension of the spring can be regulated to compensate for the resistance of the air in the chamber of the tank H , the regulating valve L , being forced outward by excessive pressure in the air chamber to move the valve k' , across the pipe k^2 , more or less in accordance with the excess of air pressure in the air chamber and thereby regulate the volume of steam passing through the pipe K , to the engine which operates the pumps; the effect being that the engine is automatically controlled by the air pressure in the air chamber of the receiving tank.

In the upper part of the shell b , forming the steam dome of the auxiliary high pressure boiler, I provide a normally operated valve N , which is in the form of a conical plug adapted to be tightly seated in an outlet opening for steam to escape from the high pressure boiler dome into the main boiler dome; and said valve can be operated from the outside of the boiler by means of a lever

n , fulcrumed to a suitable bracket in the boiler, and provided with a counterbalanced weight n' , which works in a segmental guide n^2 , said weight being geared or otherwise connected to an operating shaft N' , which extends through the side of the outside shell A , of the main boiler.

The temperature in the main dome A' can be regulated by means operated from the outside of the generator, and consisting of a screw operated shaft O , having a bearing in the outside shell A , and carrying at its inner end a valve o , which is normally seated in an opening in the inside shell B , so that when it is desired to increase the temperature in the dome A' , it is only necessary to unseat the valve o , to permit a part of the heat from the inside shell B , to pass into the outside shell without being forced into and through the water in the chamber C .

This being the construction of one form of vertical steam boiler embodying my invention, the operation may be briefly described as follows:—A small quantity of liquid or oil is placed in the cap i , and ignited, and the coil I , thereby heated so that the liquid fuel therein is vaporized, and the valves in the pipes F , G , are opened to admit air and gas to the mixer and burner which are combined as they pass through the valve E , and the gas is ignited at the burner by means of a lighted match applied thereto through a man-hole A' , in the side of the shell A , after which the manhole is closed. If desired an electric sparking apparatus may be used to ignite the fuel at the burner. When sufficient steam has been generated to run the engine, it is led through the pipes k , k^2 , to the engine and the air and liquid fuel pumps are started to supply compressed air and fuel to the tank, said pumps being independently regulated by their respective valve mechanism in the tank H . We will suppose that steam or hot air is to be kept at one hundred pounds pressure in the internal shell or combustion chamber B , and the spring that regulates the burner valve E , has a resistance equal to one pound pressure of the steam or air. The air pressure in the upper chamber of the tank H , should be kept at one hundred and two pounds pressure, and thus the air has a pressure of one pound in excess of the combined resistance in the fire chamber and the tension of the burner valve controlling spring, which extra pressure of one pound will partly open the valve E , and admit a current of air and gas through the mixer and burner and its valve. However, should the pressure in the fire chamber b , aim up to one hundred and one pounds, the valve E , would be balanced, and any additional rise in the pressure in the chamber B , even if an ounce or two of pressure would entirely close the valve E , with the exception of a small current of air and gas which passes through the openings in the valve to maintain a small flame in the burner. The valve E , being closed and the volume of heat

or air being cut off, the steam pressure cannot run up any higher but would have a tendency to go down by radiation from the outer shell A , and at the same time the pressure of air in the tank H , is slowly reduced, but should steam be drawn from the dome B' , the steam pressure would be at once reduced and the valve I , at the tank H , would open, the air pressure being reduced, thus permitting the valve I , to be forced inward by the spring (or a weight may be used) permitting steam to pass from the dome through the pipes K , K^2 , to the engine. The crank of the engine being set at an angle to the crank of the air pump to avoid dead centering, the air pump is at once started to supply air to the tank H , in proportion to the volume of steam that is withdrawn. It will be understood that the air in the tank H , is normally at a pressure sufficient to prevent the spring or weight controlling the valve L , from pressing the valve inward so that the latter is forced outward by the pressure of air in the tank and thus the valve k' , will be adjusted over the pipe k^2 , to cut off the supply of steam to the engine, in whole or in part, in proportion to the increased air pressure, thus arresting or reducing the action of the air pump until a reduction of the pressure of the current of hot air from the burner which is discharged into the combustion chamber, takes place, at which time the valve L , recedes and adjusts the valve k' , to admit more steam to the engine which again operates the pumps until the air and gas fuel are at their proper pressures in the tank H .

As a single engine is used to run all of the pumps, steam of considerable pressure is required to operate the engine, and I therefore take the steam from the auxiliary boiler in which the steam pressure is very greatly in excess of the pressure in the main boiler, as for example the steam pressure in the auxiliary boiler is at two hundred pounds to one hundred pounds pressure in the main boiler, and thus the engine can be operated with steam at one hundred pounds pressure, which represents the difference in pressure between the steam in the main and auxiliary boilers: the steam to exhaust into the main dome or main steam pipe. As the air is compressed under six or seven atmospheres, a small burner can be employed to produce the requisite quantity of heat for running the boiler, and the capacity of the burner can be varied in proportion to the difference in the pressure between the fuel supply and the pressure in the combustion chamber B , in which the pressure is regulated by varying the tension of the power valve spring. If the tension of the spring is increased, the air pressure to open the valve will have to be increased and more fuel will pass the valve E , and the resistance of the controlling mechanism for the valve L , must also be changed to adapt the valve L , to operate under the changed standard of pressure in the combustion

tion chamber which will receive a proportionately increased volume of fuel which will pass into and through the water, increasing the volume and temperature of the steam in the steam dome. In the upright form of tubular boilers shown in Figs. 2, and 3, of the drawings, the temperature of the steam in the dome of the boiler can be regulated and controlled to better advantage by the employment of a water spray through which the heat, air and products of combustion must act on and pass to generate the required volume of steam. In the simpler form of water spray upright boiler shown in Fig. 3, I employ the outer and inner shells arranged as described but omit the auxiliary high pressure boiler and its steam dome. The steam to supply engine is taken from the main dome. The combiner and mixer for the air and gaseous fuel is located in the upper part of the boiler and serves to close the upper end of the internal shell B³. The mixer and burner has the two outer and inner shells d⁵, d⁷, adapted to receive air and gaseous fuel, the inner shell d⁷, also serving as the means to receive the tension devices for the valve E, at the open discharged ends of the air and fuel chambers of the mixer and burner, the gas pipe G, discharging into the inner shell and the air pipe F, into the outer shell. The tension device and regulating means thereof are arranged in vertical positions and the operating shaft passes through the head of the shell A. In this construction the steam for running the air pumps is taken from the dome of the outer shell through the pipe K³, and the air for feeding the burner is led into the outer chamber of said burner through the pipe F³, while the oil is led into the inner chamber of the burner through the pipe G, as shown. To produce the water spray through which the heat, air, and gas, are passed and thereby tempered and converted partly into steam, the outer shell d⁵, of the mixer is provided at its lower side with a perforated ring B⁷, which forms a chamber p, into which water is supplied through a pipe p', and the lower side of this ring is perforated as shown to divide the water as it falls by gravity through the ring, into thin streams or a fine spray, into which the heated air from the burner and mixer is projected. In the upright tubular boiler shown in Fig. 2, of the drawings, I also employ the outer shell A, an inner shell B⁴, and an auxiliary high pressure boiler J³. The upper end of the inner shell B⁴, in this instance is left open while the lower end thereof is closed, and the mixer and burner are located in the lower part of the boiler, the mixer having the outer and inner shells forming the air and gas chambers which are supplied by the pipes F, G, and the valve E³, being arranged across the open ends of the valve shells and provided with the tension and regulating devices as shown. The auxiliary boiler has its water chest made of annular form with a central opening as shown in detail in

Fig. 8, and through this central opening passes the heat and currents from the mixer and burner which are discharged directly into the lower closed end of the inner shell B⁴, the water being confined between the shells A, B⁴, and prevented from entering the lower part of the shell B⁴. The auxiliary high pressure boiler has a separate shell J⁷, forming its steam dome, which dome is located near the upper part of the combustion chamber formed by the inner shell B, and it has the usual steam pipe K, leading therefrom. The steam dome J⁷, is connected by the tubes j', with the annular water chest, and the pressure of steam in the upper dome J⁷, is controlled by means of the valve N³, as shown. In this form of generator the oil is conveyed by the pipe p', to a vaporizing vessel or receptacle R, having the pipe G, extending therethrough and opening near the top of the same and around this pipe is fitted the heating coil r, which is connected at its ends to the steam and water chambers of the boiler as shown. The spray is projected above the steam dome of the auxiliary boiler and directly into the steam dome of the main boiler, and the spray device consists of a chest Q, suitably supported in the upper end of the shell B, a water supply pipe q, a conical valve S, and a regulator weight T, for this valve. The upper end of the chest Q, is provided with a discharge opening in which is seated the conical valve S, which has a guide stem working in the chest, and on the valve rests the weight T, of the regulator, said weight being carried by the long arm t, of a power lever which is suitably fulcrumed to a fixed bracket and the short arm t', of said power lever, being connected to a thermal regulator, not shown, and which may be of any approved form, as for instance a mercury tube with a head and piston or an expansible coil arranged to operate against the short arm of the power lever. The water pipe q, enters the lower end of the water chamber C, between the shells A, B⁴, and it discharges into the chest Q, at the lower part thereof. Normally the temperature of the steam in the dome of the main boiler is such that the weight T, closes the valve S, and prevents a spray; but when the temperature of the steam is raised to a degree which actuates the thermal regulator to overcome the heft of the weight T, the valve S, can be raised by the pressure of the water in the chest Q, so that the water will issue between the walls of the chest and the valve, in the form of a thin spray which is projected upwardly directly into the dome A', and in the path of the ascending currents of air and gas, the heat of which is thus tempered and converts the spray into steam. The space between the upper part of the shell B⁴, and the shell A, is closed by a diaphragm U, and in this diaphragm is seated an upwardly moving balanced valve u, which is adapted to be automatically opened when the steam in the chamber C, becomes excessive

so that the steam can escape into the dome A'. The horizontal forms of generators shown in Figs. 4, 5, and 6, embody the same generic features as the vertical tubular boilers, namely, the longitudinal outside shell A⁵, the concentric inner shell B⁸, forming a combustion chamber, and the air and gas mixer and burner, one being located at each end of the concentric shells A⁵, B⁸, see Fig. 4. The space C⁵, between the two shells is utilized as the water chamber in which the water is heated by radiation from the shell B⁸, and the steam is stopped off through a trap V, having a spring controlled flap valve v, the steam being conducted into a vertical central dome W, erected upon the boiler and having its lower end connected to the inner longitudinal shell B⁸. In vertical alignment with this upright steam dome is arranged a spraying device X, which is fitted in the lower part of the boiler and has its shell and flared valve arranged to produce and project a spray of water into the path of the currents of heated air and gas from the mixers and burners E⁹ at opposite ends of the shells A⁵, B⁸. The burners and mixers have the gas and the air supply pipes, the valves and the tension devices therefor, and the valve of the spray device is likewise provided with means for holding the same under tension and regulating the same, which means is similar to that used in controlling the valve of the mixer and burner. A single internal shell B⁸, may be used as indicated in Figs. 4, and 5, or a series of two or more internal shells B⁹, B⁹ may be used as indicated in Fig. 6, each inner shell having the mixer and burner at each end, a central spray producing device arranged to discharge immediately beneath the steam dome.

It is evident to those skilled in the art that numerous modifications may be made in the mechanism herein shown and described as embodiments of my invention, and I therefore do not confine myself to the constructions shown and described, but hold myself at liberty to make such alterations as fairly fall within the scope of my invention.

Having thus explained the nature of my invention and its several applications and in what manner the same is to be performed, what I claim as new, and desire to secure by Letters Patent, is—

1. The method of generating steam herein described, which consists in mingling a highly heated compressed current of commingled air and gas and igniting the same in a close chamber and supplying a spray of water to the combustion, substantially as and for the purpose set forth.

2. In a steam generator, the combination of an outside shell, an inner shell within the same, and communicating therewith, a combiner and burner extending into the inner shell and having separate air and gas chambers, adapted to be discharged from said mixer and burner, directly into the inner shell, and supply pipes for air and gas, connected di-

rectly to the isolated air and gas chambers of the mixer and burner, substantially as and for the purpose described.

3. In a steam generator, the combination of an outer shell, an inner shell within the same, and communicating therewith, a combiner and burner arranged to discharge directly into the inner shell, and having separate concentric chambers for air and gas, which are mixed and burned at the points of exit from the burner, suitable supply pipes to the separate chambers of the combiner and burner, and a regulating valve having the apertures e, operating to open and close the discharge ports from the chambers of the combiner and burner, substantially as described.

4. In a steam generator, the combination of an outside shell, an inside shell within the same and communicating therewith, an air and gas combiner and mixer arranged to discharge into the inner shell only, and a high pressure auxiliary boiler within the inner shell, substantially as described.

5. In a steam generator, the combination of an outer shell, an inner shell within the same, and communicating therewith, a combiner and burner having isolated gas and air chambers arranged to discharge into the inner shell only and a high pressure auxiliary boiler within the inner shell, and having its water tank in or under the lower part of said inner shell, and its steam dome in the upper part or above of said inner shell, the tank and dome being connected by intermediate tubes which extend longitudinally through the inner shell, substantially as described.

6. In a steam generator, the combination of an outer shell, an inner shell connected thereto, a combiner and burner discharging into the inner shell, a divided supply tank, having the air and fuel chambers, an air pipe connecting the air chambers of the tank and burner, and means for vaporizing the liquid from the liquid chamber of the tank, and conducting the same to the gas chamber of the burner, substantially as described.

7. In a steam generator, the combination of the outer and inner shells connected together, an auxiliary high pressure boiler, within the inner shell, and having its steam dome in the upper part of the inner shell, a combiner and burner, arranged to discharge into the inner shell, a supply tank having its air chamber connected to the air chamber in the burner and combiner, a steam supply pipe leading from the dome, of the auxiliary boiler, and an automatic valve mechanism in said steam pipe controlled by the pressure of air in the supply tank—substantially as and for the purpose described.

8. In a steam generator, the combination of the outer and inner shells communicating directly with each other, a combiner and burner discharging into the inner shell, an auxiliary high pressure boiler within the inner shell, a supply tank having its air and fuel chambers connected to the chambers of the combiner

and burner, a steam pipe leading from the dome of the auxiliary boiler, a valve operating in said steam pipe to open and close its port to the branch pipe leading to an engine or motor, and an automatic valve connected to the steam valve, and arranged in the air chamber of a supply tank, to be operated by changes of pressure therein, substantially as described.

9. In a steam generator, the combination of the connected outer and inner shells, the combiner and burner, arranged to discharge into the inner shell, and having an automatic controlling valve adapted to be operated by increased pressure in the air chamber of said mixer and burner, an auxiliary high pressure boiler, within the inner shell, a supply tank having its compartments connected to the chambers of the combiner and mixer, a steam pipe leading from the dome of the auxiliary boiler, and an automatic valve mechanism in the steam pipe, and arranged to be operated by changes of pressure in the air chamber of the supply tank, substantially as described.

10. In a steam generator, the combination of the outer and inner shells connected directly with each other, the combiner and burner, having its air and gas chambers arranged to discharge into the inner shell, an automatic pressure valve which controls the outlet ports from the combiner and burner, an auxiliary boiler within the inner shell, a supply tank divided into air and liquid fuel compartments, a pipe from the air chamber of the tank to the combiner, another pipe from the fuel chamber of said tank to the combiner,

and having means for vaporizing the fuel on its passage to the combiner, a steam pipe leading from the steam dome to the auxiliary boiler, and having a valve, and independent regulator mechanism in the air and fuel chambers of the supply tank, substantially as described.

11. In a steam generator, the combination of the outer and inner shells communicating directly with each other, the combiner and burner, having the separate chambers for air and gas arranged to discharge directly into the inner shell, a single regulating valve for both chambers of the combiner and mixer, having suitable tension mechanism, and suitable supply pipes for the air and gas chambers of the combiner and burner, substantially as described.

12. In a steam generator the combination of the inner and outer shells, communicating at the lower ends thereof, the combiner and burner, having its valve, air, and gas chambers discharging into the inner shell, an auxiliary boiler with its water chest at the base of the inner shell, and having the tubes, connected to the separate steam dome near the upper part of the inner shell, and pipes leading from a source of supply to the combiner and burner, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

THOMAS A. MARRIOTT.

Witnesses:

ROYAL A. JENNEY,
PATRICK GORMELY.